IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Joseph P. Bigus, et al.	:	Date: June 25, 2007
Group Art Unit:	2129	:	IBM Corporation
Examiner:	O. Fernandez Rivas	:	Intellectual Property Law
Serial No.:	10/712,563	:	Dept. 917, Bldg. 006-1
Filed:	November 13, 2003	:	3605 Highway 52 North
Title: METHOD, APPARATUS AND PROGRAM PRODUCT FOR MATCHING MULTIVARIATE DATA TO FUZZY SETS		:	Rochester, MN 55901

Commissioner for Patents
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APPEAL BRIEF IN SUPPORT OF APPEAL

FROM THE PRIMARY EXAMINER TO THE BOARD OF APPEALS

Sir:

This is an appeal of a Final Rejection under 35 U.S.C. §102(b) and 35 U.S.C. §103(a) of claims 1-30 of Application Serial No. 10/712,563, filed November 13, 2003. This brief is submitted pursuant to a Notice of Appeal filed April 24, 2007, as required by 37 C.F.R. §1.192.

1. Real Party in Interest

International Business Machines Corporation of Armonk, NY, is the real party in interest. The inventors assigned their interest as recorded on November 13, 2003, on Reel 014707, Frame 0218.

2. Related Appeals and Interferences

There are no related appeals nor interferences pending with this application.

3. Status of Claims

Claims 1-30 are pending and stand finally rejected. The claims on appeal are set forth in the Appendix of Claims

4. Status of Amendments

No amendments were submitted following Final Rejection.

5. Summary of Claimed Subject Matter

The invention herein relates to the use of so-called “fuzzy logic” for characterizing “curves”, i.e. using “fuzzy logic” to characterize a curve of multiple data points expressing a functional relationship, as opposed to conventional use of fuzzy logic to characterize individual data points. Independent claims 1, 7, 12 and 18 are apparatus claims reciting a “curve matching mechanism” which uses fuzzy logic to describe a curve represented by curve data. Independent claim 24 is a method claim reciting a step of describing a curve represented by curve data using fuzzy logic. Independent claim 30 is a method claim reciting a step of determining membership of a curve in at least one fuzzy set.

In accordance with claims 1, 7, 12 and 18, an apparatus (claims 1, 7 and 12) or program product (claim 18) contains a controller or fuzzy controller [Spec. ¶0007, ¶0022; Fig. 2, feature 202]. Independent claim 12 further recites that the apparatus contains an engine, the fuzzy controller executing on a processor associated with the engine [Spec. ¶[0007, ¶0017-0020; Fig. 1, features 100, 150]. The apparatus or program product further contains a curve matching mechanism executing under the direction of the (fuzzy) controller [Spec. ¶0022; Fig. 2, feature 205]. The curve matching mechanism receives data points representing a curve, and uses fuzzy logic to describe the curve represented by the data points [Spec. ¶0024-0028; Figs.4A, 4B]. The curve data description is used to control the apparatus (claims 1, 7 and 12) [Spec. ¶0007, ¶0029; Fig. 3 step 330].

In accordance with claim 24, curve data comprising data points representing a curve is received [Spec. ¶0024; Figs.4A, step 415]. The curve represented by the curve data is described using fuzzy logic [Spec. ¶0024-0028; Figs.4A, 4B]. The curve data description is used to control an apparatus [Spec. ¶0007, ¶0029; Fig. 3 step 330].

In accordance with claim 30, data representing an input curve is received [Spec. ¶0024; Figs.4A, step 415]. Membership of the input curve in at least one fuzzy set is determined, the fuzzy set expressing a property of a curve [Spec. ¶0024-0028; Figs.4A, 4B]. A membership value representing degree of membership in the fuzzy set is output [Spec. ¶0024, ¶0028; Figs.4A, step 430]. The output membership value is used to control an apparatus [Spec. ¶0029; Fig. 3 step 330].

6. Grounds of Rejection To Be Reviewed on Appeal

Claims 1-11 and 18-30 are finally rejected under 35 U.S.C. §102(b) as anticipated by Steven D. Kaehler, "Fuzzy Logic", parts 1-6 (herein *Kaehler*).[1] Claims 12-17 are rejected under 35 U.S.C. §103(a) as unpatentable over *Kaehler* in view of Kamihira (U.S. Patent 6,278,986). The only issues in this appeal are whether the claims are either anticipated by *Kaehler*, or prima facie obvious over *Kaehler*, and/or *Kamihira*.

7. Argument

Appellants contend that the Examiner failed to establish adequate grounds of rejection for the following reasons:

I. The Examiner improperly rejected independent claims 1, 7, 18 and 24 (and claims dependent thereon) under 35 U.S.C. §102(b) because *Kaehler* does not disclose key claim limitations, specifically that fuzzy logic is used to describe a curve represented by multiple data points [page 7 below].

II. The Examiner improperly rejected independent claim 30 under 35 U.S.C. §102(b) because *Kaehler* does not disclose key claim limitations, specifically determining membership of an input curve in a fuzzy set which expresses a property of a curve [page 11 below].

III. The Examiner improperly rejected the claims under 35 U.S.C. §103(a) because neither *Kaehler* nor the secondary reference, alone or in combination, fairly teach or suggest the key claim limitations. [page 12 below].

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[1] The first sentence of Section 4 of the final office action states that claims 1-11, 13-16 and 18-29 are rejected as anticipated. However, claims 13-16 are dependent on claim 12, and can not be anticipated unless claim 12 is anticipated. Moreover, the body of Section 4 gives grounds of rejection for claim 30, although none for claims 13-16. Appellants therefore deem this a typographical error, and understand the anticipation rejection to be directed to claims 1-11 and 18-30.

Overview of Invention

A brief overview of appellants' invention in light of existing art will be helpful in appreciating the issues herein. Appellants' invention relates to the characterization of data functions using fuzzy logic, especially where some data value is measured as a function of time. It is potentially useful in variety of process control applications, where it is desirable to characterize a trend in data over a period of time. The exemplary embodiment is a control system for a vehicle engine, it being understood that many other embodiments are possible.

Conventionally, so-called "fuzzy logic" is used to characterize individual data values, often in measured data. For example, measured data taken from a sensor may occupy a range of a physical parameter, such as temperature, volume, pressure, velocity, etc. For purposes of process control or other analysis, it may be desirable to characterize the value (hot or cold, large or small, high or low, fast or slow, etc.). However, measured values are often neither one nor the other, and lie somewhere in the middle of a measured range. In this case, it is possible to assign a characterization corresponding to the nearest extreme, but such a characterization becomes less accurate for values in the middle of the range. Fuzzy logic therefore assigns a non-boolean value to characterize these measured values. This non-boolean value is typically a floating-point value in the range of zero to one, and represents "degree" of membership in a fuzzy set, the fuzzy set representing a quality of the measured value. For example, if temperature is being measured, a fuzzy set may represent the quality "hot". The measured data values are then assigned a degree of membership in the fuzzy set "hot", with very hot values having a high degree (close to 1), very cold values having a degree close to 0, and intermediate values having some intermediate degree of membership in the fuzzy set "hot".

Appellants observed that it is sometimes useful to characterize relationships in data, and particularly the change of a measured value over time. Often, this direction or drift of a measured value is more important than the value itself. For example, rather than to identify a temperature measurement as "hot" to some degree, it may be more valuable to identify the trend of temperature over time, such as "temperature constant", "temperature increasing monotonically", "temperature increasing at accelerating rate", etc. However, measured data frequently does not exactly match some pre-determined model.

Appellants therefore determined to apply fuzzy logic set membership concepts to data functions, i.e. "curves" of data, as opposed to individual measured values or data points. In accordance with appellants' preferred embodiment, a curve of data (which preferably represents change in a measured value over time) is compared to a property of a curve (such as constant, accelerating, etc.) to determine degree of membership in a fuzzy set representing that property of the curve. The resultant degree expresses an extent to which ***the curve*** (not the individual data points) matches the corresponding ***property of a curve***.

Therefore, appellants' independent claims recite that fuzzy logic is used to describe a ***curve***, or more particularly in the case of independent claim 30, that membership of a ***curve*** in a fuzzy set is determined, the fuzzy set expressing ***a property of a curve***. The use of fuzzy logic to characterize a property of a curve (as opposed to individual data values) is not disclosed or suggested in the art.

I. The Examiner improperly rejected independent claims 1, 7, 18 and 24 (and claims dependent thereon) under 35 U.S.C. §102(b) because *Kaehler* does not disclose key claim limitations, specifically that fuzzy logic is used to describe a curve represented by multiple data points.

In order to support a rejection for anticipation, each and every element of the claimed invention must be shown in a single prior art reference. Appellants' claims are not anticipated by *Kaehler* because, inter alia, *Kaehler* fails to teach using fuzzy logic to describe a curve represented by a plurality of data points.

Kaehler is a series of articles providing a generalized description of fuzzy logic and some representative uses. An exemplary application is a temperature control system with feedback. In this application, at least one temperature sensor senses a controlled environment, providing a series of temperature readings over time. I.e., collectively these readings would represent a curve of temperature vs. time. *Kaehler* discloses that a fuzzy logic engine determines membership of each individual temperature reading in a fuzzy logic set called "error", i.e. a range of negative, zero, positive temperature error with respect to some ideal temperature value. *Kaehler* further discloses that the fuzzy logic engine determines membership of each of a plurality of different values in a fuzzy logic set called "error-dot". Each value of error-dot is a time derivative of temperature at an instant in time.

Appellants' representative claim 1 recites:

1. An apparatus, said apparatus comprising:

a controller, and

a curve matching mechanism that executes under the direction of said controller, said curve matching mechanism receiving curve data as an input, said curve data comprising *a plurality of data points representing a curve,* said curve matching mechanism *using Fuzzy Logic to describe said curve represented by said curve data* and to thereby create curve data description information, said curve data description information then being available to said controller. [emphasis added]

Independent claims 7, 18 and 24 contain similar limitations to the italicized language above.

If one carefully considers each limitation of the above claim, it is clear that the limitations are not met by *Kaehler*. *Kaehler* does indeed disclose receiving a plurality of data points as input, and since these data points represent temperature (or instantaneous change in temperature) vs. time, it can be said that they collectively "represent a curve". ***But Kaehler's fuzzy logic is used to describe the data points, not the cure represented by the data points.***

The distinction may be a subtle one, but many great inventions are based on subtlety. The Examiner is not entitled to ignore a distinction clearly expressed in the claims, merely because it is subtle.

The claims recite the use of "fuzzy logic" to "describe" something. In the field of fuzzy logic, this clearly means characterizing something by a degree, as a degree of membership in a fuzzy set. But what is it that the claims recite being described? The object of the verb "describe" in claim 1 is not "data points"; it is "curve". Claim 1 recites that a "curve" is being described, i.e., that a degree of some property is being assigned to

the "curve" by the fuzzy logic controller. This is clearly different from assigning a degree of some property to each of a plurality of individual data points which represent the curve.

Kaehler discloses an entirely conventional use of fuzzy logic in which each of multiple data points is assigned a degree of membership in a fuzzy set. Yes, the data points collectively represent a curve, but there is no disclosure of the curve itself being described by fuzzy logic. Only individual data points, i.e., scalar quantities, are matched for membership in the fuzzy set.

The Examiner makes the point, which is worthy of a response, that *Kaehler* discloses matching data points expressing an instantaneous time derivative of temperature to an "error-dot" membership function. A time derivative is something derived from or relating to a property of the curve of temperature data vs. time. The Examiner therefore reasons that, by determining membership of time derivative in the "error-dot" fuzzy set, *Kaehler* discloses using fuzzy logic to "describe" a curve.

The flaw in this argument is that it confuses two separate sets of data, and finds a claim limitation in a known mathematical relationship between the two separate data sets which reaches beyond the scope of what the fuzzy logic engine does. *Kaehler* does not disclose, and we simply do not know, how the individual data points of instantaneous time derivative of temperature vs. time are obtained. It is possible that a sensor directly senses instantaneous time derivative. It is also possible that some external logic calculates or estimates an instantaneous time derivative from the measurements taken by the temperature sensor at various times. *Kaehler*'s fuzzy logic engine does not know or care. It simply receives data points associated with an instant of time, be they

instantaneous temperature, or instantaneous time derivative of temperature, and matches ***each of the individual data points*** to the corresponding membership function to obtain a degree of membership in the corresponding fuzzy set.

Claim 1 recites that the curve matching mechanism receives "a plurality of data points representing a curve" and uses fuzzy logic to "describe ***said curve***", i.e. the curve represented by the data point input. *Kaehler*'s fuzzy logic engine receives a plurality of data points representing a curve of temperature vs. time. But it does not describe the curve of temperature vs. time; it describes the data points. *Kaehler*'s fuzzy logic engine separately receives a plurality of data points representing a curve of instantaneous time derivative of temperature vs. time. But it does not describe the curve of instantaneous time derivative of temperature vs. time; it described the data points. It is true that each individual data point of the curve of instantaneous time derivative of temperature vs. time relates in a general way to a property of a different curve (i.e. the curve of temperature vs. time), but the claim recites describing ***"said curve"***, i.e. the one represented by the data points. *Kaehler* does not disclose this.

For all the reasons specified above, *Kaehler* does not anticipate key limitations of appellants' independent claims 1, 7, 18 and 24 (and claims dependent thereon), and the Examiner's rejections thereof were erroneous.

II. The Examiner improperly rejected independent claim 30 under 35 U.S.C. §102(b) because *Kaehler* does not disclose key claim limitations, specifically determining membership of an input curve in a fuzzy set which expresses a property of a curve.

Claim 30 was also rejected as anticipated by *Kaehler*. Although in general it relates to the same subject matter, the language of claim 30 is sufficiently different for separate consideration. Claim 30 recites:

> 30. A method, said method comprising the steps of:
>
> receiving data representing an input curve as input;
>
> *determining membership of said input curve in at least one Fuzzy Set, each said Fuzzy Set expressing a property of a respective at least one curve*;
>
> outputting at least one respective input curve membership value representing degree of membership of said input curve in each said Fuzzy Set; and
>
> using said at least one respective input curve membership value to at least partially control an apparatus. [emphasis added]

Kaehler is explained above in Part I, and the discussion therein is background herein as well. As explained above, *Kaehler* discloses that individual data points of a curve are matched for membership in a fuzzy set. No matter how *Kaehler* is characterized, the only thing *Kaehler*'s fuzzy logic engine does is receive a ***scalar value*** and determine its membership in a fuzzy set. *Kaehler* does not disclose "determining membership of said ***input curve*** in at least one Fuzzy Set", as recited in claim 30, because a scalar value is not an "input curve".

It is true, as the Examiner observes, that *Kaehler* discloses that the input scalar values that it's fuzzy logic engine receives represent an instantaneous time derivative of temperature vs. time, and that this relates to a property of the curve of temperature vs.

time. However, this does not meet the plain claim limitation. The claim recites determining membership of a curve in a fuzzy set, not determining membership of scalar values, whatever those scalar values may represent. Appellant observes that almost any scalar value representing a measured physical quantity might, by mathematical manipulation and known physical laws, by said to represent a relationship of some other physical quantity. Thus, a measured electrical current represents, by Ohm's law, a relationship between voltage and impedance, a mass of an object represents a relationship between volume and density, and so on. A "curve", no matter how brief and no matter how precise, is not a scalar value. The claim recites determining membership of a "curve" in a fuzzy set; *Kaehler* discloses only determining membership of scalar values.

For all the reasons stated above, *Kaehler* does not anticipate appellants' claim 30, and the rejection thereof was erroneous.

III. The Examiner improperly rejected the claims under 35 U.S.C. §103(a) because neither *Kaehler* nor the secondary reference, alone or in combination, fairly teach or suggest the key claim limitations. [2]

From the discussion above, it can be seen that although *Kaehler* indeed relates to the subject of fuzzy logic and use of fuzzy logic membership sets, it is entirely conventional in that is determines the degree of membership of a scalar value in a fuzzy membership set. Among the scalar values it uses are an instantaneous time derivative of temperature, which is a quantity representing a mathematical relationship between temperature and time. But although there exists such a mathematical relationship,

[2] Generally, a rejection for anticipation under 35 U.S.C. §102 may be deemed to include an implied or "subsumed" single reference rejection for obviousness under 35 U.S.C. §103. The subsumed obviousness rejection is addressed here.

Kaehler's fuzzy logic engine is not aware of it, nor does it use it to determine membership in the corresponding fuzzy set. *Kaehler*'s fuzzy logic engine receives scalar values as inputs, and determines a degree of membership of each scalar value in fuzzy set. And that's all it does.

There is simply no suggestion or other basis in *Kaehler* or in the art to extend *Kaehler*'s teachings to apply fuzzy set membership concepts to a curve of data represented by multiple data points, and to determine a degree of membership of the curve in a fuzzy set. It therefore would not have been obvious, given *Kaehler*, to find the recited elements of appellants' claims.

The secondary reference, *Kamihira*, is cited to show a control system for a vehicle engine, as recited in appellants' claims 12-17. *Kamihira* discloses an adaptive feedback control system, which is trained to the driving proclivities of an individual driver. Although *Kamihira* mentions that fuzzy logic systems might be used for control, it does not describe in detail the functioning of fuzzy logic systems and fuzzy set membership concepts.

Appellants' do not challenge the combination of *Kaehler* and *Kamihira*, nor do they dispute that it would have been obvious to apply a fuzzy logic control system such as disclosed in *Kaehler* to the control of a vehicle engine. However, for the reasons stated above, such a combination does not teach or suggest the significant limitations of appellants' claims, i.e., the use of fuzzy logic to describe a "curve" or determine membership of a "curve" in a fuzzy set.

For the reasons above stated, the claims are not obvious in view of *Kaehler*, either alone or in combination with *Kamihira*.

8. Summary

Appellants disclose and claim a novel and non-obvious technique for using fuzzy logic, in which a curve of multiple data points is described by fuzzy logic (claims 1-29) or membership of a curve in a fuzzy logic set is determined (claim 30). The use of fuzzy logic by determining a membership degree in a fuzzy set is well known, but conventional uses, as typified by the primary reference, compare a scalar value to a fuzzy set property to determine membership in the fuzzy set. By comparing a curve of values to determine membership of the curve in a fuzzy set, appellants have invented a novel an non-obvious extension of prior art fuzzy logic concepts.

For all the reasons stated herein, the rejections for anticipation and obviousness were improper, and appellants respectfully request that the Examiner's rejections of the claims be reversed.

Date: June 25, 2007

Respectfully submitted,

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APPENDIX OF CLAIMS

1. An apparatus, said apparatus comprising:

a controller, and

a curve matching mechanism that executes under the direction of said controller, said curve matching mechanism receiving curve data as an input, said curve data comprising a plurality of data points representing a curve, said curve matching mechanism using Fuzzy Logic to describe said curve represented by said curve data and to thereby create curve data description information, said curve data description information then being available to said controller.

2. The apparatus of claim 1 wherein said controller is a Fuzzy Logic controller that executes on a processor.

3. The apparatus of claim 1 wherein said curve data is time series data.

4. The apparatus of claim 1 wherein said curve data is described by comparing said curve data to at least one standard curve, said at least one standard curve being a Fuzzy Set.

5. The apparatus of claim 1 wherein said curve data description information is an output curve.

6. The apparatus of claim 5 wherein said at least one output curve shows a degree of similarity between said curve data and said at least one standard curve.

7. An apparatus, said apparatus comprising:

a Fuzzy Controller that executes on a processor, and

a curve matching mechanism that executes under the direction of said Fuzzy Controller, said curve matching mechanism receiving curve data as an input, said curve data comprising a plurality of data points representing a curve, said curve matching mechanism using Fuzzy Logic to describe said curve represented by said curve data and to thereby create curve data description information, said curve data description information then being available to said Fuzzy Controller, said Fuzzy Controller then using said curve description information to at least partially control said apparatus.

8. The apparatus of claim 7 wherein said curve data is time series data.

9. The apparatus of claim 7 wherein said curve data is described by comparing said curve data to at least one standard curve, said at least one standard curve being a Fuzzy Set.

10. The apparatus of claim 7 wherein said curve data description information is an output curve.

11. The apparatus of claim 10 wherein said at least one output curve shows a degree of similarity between said curve data and said at least one standard curve.

12. An apparatus, said apparatus comprising:

an engine;

a Fuzzy Controller that executes on a processor, said processor being associated with said engine; and

a curve matching mechanism that executes under the direction of said Fuzzy Controller, said curve matching mechanism receiving curve data as an input, said curve data comprising a plurality of data points representing a curve, said curve matching mechanism using Fuzzy Logic to describe said curve represented by said curve data and to thereby create curve data description information, said curve data description information then being available to said Fuzzy Controller, said Fuzzy Controller then using said curve description information to at least partially control said apparatus.

13. The apparatus of claim 12 wherein said curve data is time series data.

14. The apparatus of claim 12 wherein said curve data is described by comparing said curve data to at least one standard curve, said at least one standard curve being a Fuzzy Set.

15. The apparatus of claim 12 wherein said curve data description information is an output curve.

16. The apparatus of claim 15 wherein said at least one output curve shows a degree of similarity between said curve data and said at least one standard curve.

17. The apparatus of claim 12 wherein said engine is contained within a vehicle.

18. A program product, said program product comprising:

a controller, and

a curve matching mechanism that executes under the direction of said controller, said curve matching mechanism receiving curve data as an input, said curve data comprising a plurality of data points representing a curve, said curve matching mechanism using Fuzzy Logic to describe said curve represented by said curve data and to thereby create curve data description information, said curve data description information then being available to said controller.

19. The program product of claim 18 wherein said controller is a Fuzzy Logic controller that executes on a processor.

20. The program product of claim 18 wherein said curve data is time series data.

21. The program product of claim 18 wherein said curve data is described by comparing said curve data to at least one standard curve, said at least one standard curve being a Fuzzy Set.

22. The program product of claim 18 wherein said curve data description information is an output curve.

23. The program product of claim 22 wherein said at least one output curve shows a degree of similarity between said curve data and said at least one standard curve.

24. A method, said method comprising the steps of:

receiving curve data as input, said curve data comprising a plurality of data points representing a curve;

describing said curve represented by said curve data using Fuzzy Logic to create curve data description information; and

using said curve data description information to at least partially control an apparatus.

25. The method of claim 24 wherein said step of at least partially controlling an apparatus is performed by a Fuzzy Logic controller that executes on a processor.

26. The method of claim 24 wherein said curve data is time series data.

27. The method of claim 24 wherein said curve data is described by comparing said curve data to at least one standard curve, said at least one standard curve being a Fuzzy Set.

28. The method of claim 27 wherein said curve data description information is an output curve.

29. The method of claim 24 wherein said at least one output curve shows a degree of similarity between said curve data and said at least one standard curve.

30. A method, said method comprising the steps of:

receiving data representing an input curve as input;

determining membership of said input curve in at least one Fuzzy Set, each said Fuzzy Set expressing a property of a respective at least one curve;

outputting at least one respective input curve membership value representing degree of membership of said input curve in each said Fuzzy Set; and

using said at least one respective input curve membership value to at least partially control an apparatus.

APPENDIX OF EVIDENCE

No evidence is submitted.

APPENDIX OF RELATED PROCEEDINGS

There are no related proceedings.